

There are the following JAVA classes implementing the multi-frontal direct solver algorithm for time dependent problem:

- *A.java*
- *A1.java*
- *A2.java*
- *AN.java*
- *Aroot.java*
- *BS.java*
- *E2.java*
- *Eroot.java*
- *Executor.java*
- *Main.java*
- *P1.java*
- *P2.java*
- *P3.java*
- *Production.java*
- *Vertex.java*

We focus now on the Euler scheme with respect to time mixed with finite element method with linear basis functions for space. We have already reimplemented all the classes responsible for generation of element matrices, as well as we have added the element diameter h , the time step dt , and the previous time step solution `x_old` to *Vertex* class.

We need now to update the Executor class so it works in a loop, for particular time steps:

```
1 class Executor extends Thread {
2     public synchronized void run() {
3         // CONSTRUCTION OF ELIMINATION TREE
4         ...
```

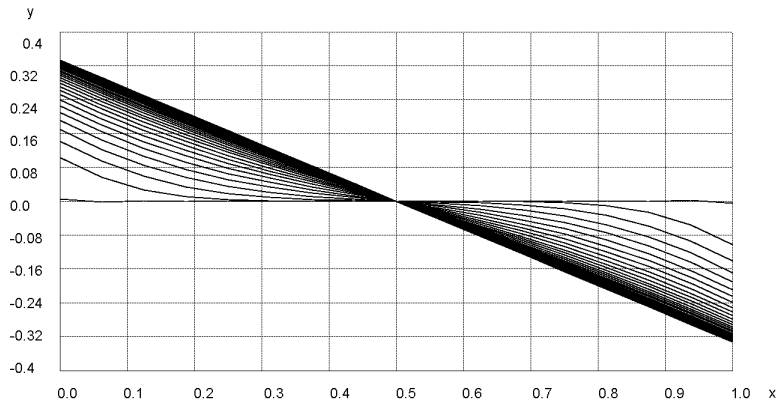


Figure 1: Exemplary plot with the solutions from particular time steps.

```

5      N = ... // Static number of intervals and time step
6      Production.h = 1 / N;
7      Production.dt = 0.001 / N;
8      // x_old = 0 set by constructor
9      // LOOP with respect to time steps
10     for(step=1; step<1000; step++)
11     {
12         // MULTI-FRONTAL SOLVER ALGORITHM
13         ...
14         // LOOP with respect to time steps
15     }
16 }
17 }

```

1. Please finish the implementation, compile and run the code.
2. Please extend the Executor class so it generates elimination trees of size 2^k .
3. Please add a class responsible for plotting of the numerical solution, e.g., through interfacing with *gnuplot*. Please execute the non-stationary algorithm and generate the plot of the solutions from particular time steps, like the one presented in Figure 1.
4. Please experiment with different time steps and check the convergence

of the Euler method. In particular, please refer to CourantFriedrichsLewy (CFL) condition relating the mesh size with the time step size. Please perform numerical experiments checking the CFL condition.